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Title	Evaluating ten years of operation of the ecosan system at a family-owned farm and restaurant in Bavaria, Germany
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Evaluating ten years of operation of the ecosan system at a family-owned farm and restaurant in Bavaria, Germany

The cattle farm and restaurant “Michelbacher Hof” is a family-owned business that has been using ecosan principles for liquid waste management since 1994. At that time, the farmer was adding an on-site slaughterhouse to his business, and had three wastewater management options:

1. Build a local decentralised wastewater treatment plant for the wastewater generated from the restaurant and slaughterhouse;
2. Be connected on his own cost to the town sewer, which is 2.5 km away; or
3. Use an integrated concept where the wastewater and waste of the entire farm, households and restaurant would be beneficially reused for its energy and fertiliser value.

The third option was chosen. The reasons for this choice, and how it has worked out in practise for the last ten years, are described in this paper. The farm that is the focus of this paper is located in Bessenbach, near Aschaffenburg in northern Bavaria in Germany. The farmer owns 280 cattle, 50 horses and 200 ha land, of which 170 ha is for grazing and fruit trees, and 30 ha is used to grow fodder and field crops for the cattle, horses and the farm-owned bakery. The farm produces hornless cattle for meat production and breeding purposes. Each week one of the cattle is slaughtered and sold in the restaurant and the farm shop. The restaurant has 260 seats, and 4 families (14 persons) live and work at this farm. The farm uses no externally produced fertiliser.

A biogas plant was constructed in 1993 to deal with the liquid and solid organic waste from the farm houses, restaurant and slaughterhouse. The wastewater from the restaurant and farmhouses is collected by gravity in a storage tank (the toilets do not have urine separation) on the lowest point of the farm area. Twice per day a certain amount is pumped to a channel-shaped manure storage tank, which is located under the cattle shed.

In the cattle shed, manure from the cows falls through gaps in the floor into the manure storage tank. There it is mixed with the wastewater and then pumped up to five times per day at a rate of about 6-9 m³/d to anaerobic digester no. 1 (280 m³ volume, fully mixed). In addition there is a feeding device to digester no. 1 for solid organic waste such as straw residues, solid organic waste from the restaurant and slaughterhouse, and hot vegetable oil from the kitchen. A second anaerobic digester (1500 m³ volume) is placed in series to

digester no. 1, and also acts as a storage tank for the pre-digested manure/wastewater/waste-mix and as a main gas holder (about 30 days hydraulic retention time in digester no. 1 and at least 4 months (winter time) in digester no. 2). Both digesters have flexible plastic covers for biogas collection.

Generally a minimum of 400 m³/day of biogas is produced in winter, while only 100 m³/day is produced in summer (in summer there is less manure production because the cattle are grazing outside). The biogas is used for electricity and heat generation in a cogeneration plant (2*37 kW electricity generators). Heat is used for the buildings and hot water (e.g. for use in the slaughterhouse). It is also used to heat the content of digester no. 1 to 37°C (mesophilic conditions) and the excess heat to heat non-insulated digester no. 2. The electricity produced is used on site, and any excess is fed into the general electricity grid. The digested effluent from digester no. 2 is used as fertiliser on the farmland. A simplified process flow diagram for reuse pathways is provided in Fig. 1 below.

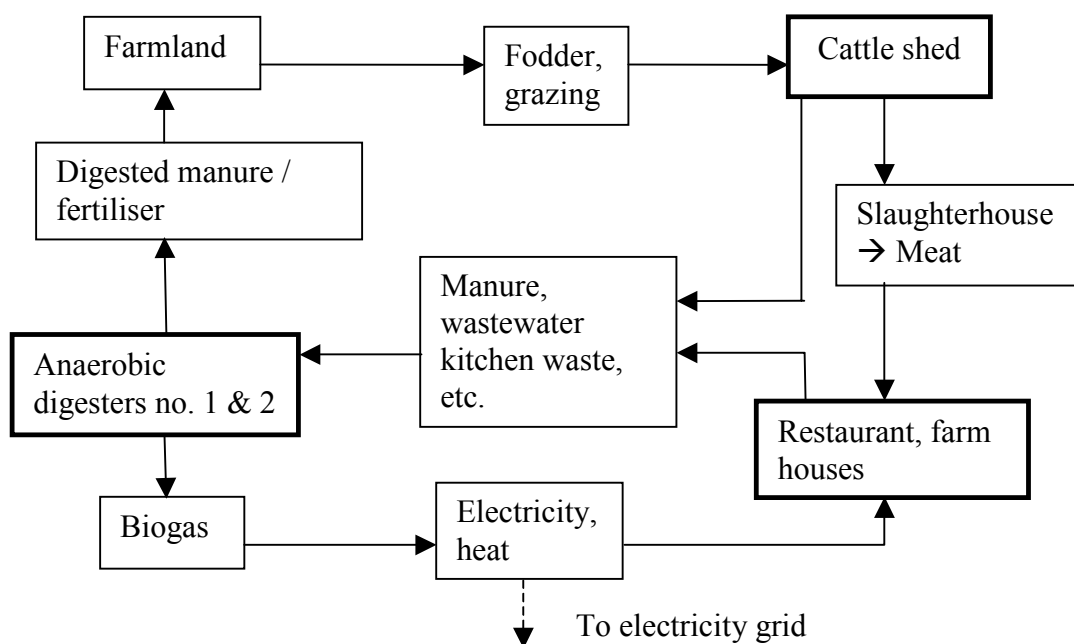


Fig 1. Simplified process flow diagram to show nutrient and energy recovery

This is a good example of an ecologically sustainable system in a rural context. Liquid and solid organic wastes generated at the Michelbacher Hof are used to produce electricity, heat and fertiliser. It is a closed-loop system, where negligible amounts of nutrients are added or removed. Further benefits are that the farmer has observed better yields with the digested manure compared to raw manure. There are also no odour problems when applying the digested manure to the fields twice per year.

The full paper will provide details on:

- Capital and operating costs;
- Commissioning problems and how they were solved;
- Nutrient balance of the system demonstrating that the amount of fertiliser value obtained through the biogas plant is appropriate; and
- Comparison of the installed system with a “conventional” approach (decentralised wastewater treatment system and/or connection to local sewer), using published sustainability criteria (financial, environment, health, technical).